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SECOND PROGRESS REPORT OF INVESTIGATION FROM JAPANESE MAGSAT TEAM*

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TITLES OF JAPANESE MAGSAT INVESTIGATIONS (Statement of Work #M-43)

A. Crustal Structure near Japan and its Antarctic Station
   - A-1. Regional Magnetic Charts
   - A-2. Local Magnetic Anomalies and Their Origin
   - A-3. Crustal Structure in the Antarctic

B. Electric Currents and Hydromagnetic Waves in the Ionosphere and the Magnetosphere
   - B-1. Ionospheric and Magnetospheric Contributions to Geomagnetic Variations
   - B-2. Field-Aligned Currents
   - B-3. Geomagnetic Pulsations and Hydromagnetic Waves

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Investigation Period: November 15, 1980 — March 15, 1981

* The Japanese MAGSAT Team consists of the following members:

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The following collaborators participated in data analysis during this investigation period.
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M. Yanagisawa (Inst. Space & Aeronautical Sci., Univ. Tokyo, Tokyo 153),
T. Kamei and T. Iyemori (Geophysical Inst., Kyoto University, Kyoto 606),
T. Nakatsuka and Y. Ono (Geological Survey of Japan, Tsukuba 305).

(E81-10096) JAPANESE MAGSAT TEAM. A: CRUSTAL STRUCTURE NEAR JAPAN AND ITS ANTARCTIC STATION. B: ELECTRIC CURRENTS AND HYDROMAGNETIC WAVES IN THE IONOSPHERE AND THE MAGNETOSPHERE Progress Report, 15 G3/43 N81-26517 Unclas 00096

1. Introduction

Since the Japanese MAGSAT Team has 19 registered Co-Investigators for 6 different subjects (3 each for internal and external magnetic fields), the progress reports will be prepared in the following way, i.e. a summary of all investigation results is written by the Principal Investigator, and the details of each investigation will be attached as Appedices as appropriate.

It is necessary for the Japanese Team to distribute copies of the MAGSAT tapes to Co-Investigators working at different places in Japan. By courtesy of the kind offer from the Data Processing Division of the National Institute of Polar Research (abbreviated hereafter to NIPR), MAGSAT data received by the Principal Investigator are being handled first by NIPR for easier analysis by Co-Investigators.

For the past four months, efforts have continued in compiling tapes which contain vector and scalar data decimated at an interval of 0.5 sec, together with time and position data. Regarding the data analysis, progress was seen in the study of magnetic anomalies in the vicinity of Japan and electric currents in the ionosphere and magnetosphere.

2. Graphical Display of MAGSAT Data

From the original CHRONINT and CHRONFIN data tapes received from NASA, a compilation of data is being carried out at NIPR, so as to obtain 3-components (X, Y and Z) as well as their residuals from the MGST(6/80) model with the indication of UT, magnetic local time, invariant latitude, geographic longitude and altitude. These are basic materials for analysis.

3. Ground Magnetic Data

In order to investigate the crustal magnetic structures in the vicinity of Japan, all available surface magnetic data are under compilation. S. Oshima is now undertaking the laborious work including also the marine data in the vicinity of Japan.

The world magnetograms for the period of MAGSAT observations are being collected for comparison of satellite and ground data. T. Iijima and R. Fujii are trying to compare the provisional field-aligned signatures with the simultaneous magnetic variations on the ground in high latitudes. Y. Kamide is planning to compare the MAGSAT data with the ground magnetic data of the Alaskan chain stations. H. Maeda and his collaborators are analyzing the Sq

variation with the ground magnetic data which are coming in to WDC C2 for Geomagnetism.

4. Preliminary Results of MAGSAT Data Analysis

4-1. Geomagnetic anomalies around Japan

Techniques for modelling the regional magnetic field are now being explored. The first problem to be solved in this modelling is how to reduce the data obtained at various altitudes of MAGSAT orbits to those at a common level of altitude. T. Nakatsuka and Y. Ono are making softwares for the upward continuation based on an equivalent source concept. T. Yukutake is considering application of the Fourier analysis technique to the vector data in a restricted area over Japan, by which he expects to obtain the field distribution at any level in a straightforward way.

M. Yanagisawa, M. Kono and T. Yukutake have analyzed the CHRONINT data of 21 paths in the area of latitude 10-70°N and longitude 110-170°E on magnetically quiet periods (K-index less than 2). They obtained a map of total force anomaly after subtracting the field model of MGST(6/80) and the ring current effect. Fig. 1 shows two nearby paths on November 3 and 6, 1979, and the ring current correction was made by the best-fit binomial equation in the latitude range of 10-70°N. With this correction the latitudinal profiles of the total force anomaly become similar to one another along nearby orbits. Fig. 2 is a preliminary map of total force anomaly around Japan obtained from 21 paths' data during November 2-11, 1979. The altitude of the MAGSAT orbit ranges from about 350 km to 500 km. Although no altitude correction has been made, a fairly consistent map is obtained. One of the outstanding features in the map of Fig. 2 is a negative magnetic anomaly in the Okhotsk Sea (amounting to -8 nT), which is of a geophysical interest because of its possible connection with high heat flow values in that area.

4-2. Field-aligned currents in high latitudes

T. Iijima and R. Fujii examined the vector residuals from MGST(6/80) model in high latitudes during November 2-30, 1979. They found the following noteworthy features, as shown in Fig. 3.

1) The total force perturbation ΔF is almost ascribable to $\Delta B_{\parallel}$ (the perturbation parallel to the main geomagnetic field), and the contribution from $\Delta B_{\perp}$ (the perturbation transverse to the main field) to ΔF is negligibly small.

2) $\Delta\vec{B}_{\perp}$ is thought to be mainly due to the field-aligned sheet currents (so-called Region 1 and 2 currents); this is concluded after resolving $\Delta\vec{B}_{\perp}$ into

geomagnetic N-S and E-W components. The sheet currents in Regions 1 and 2 vary their intensities, locations and latitudinal widths during substorms.

3) $\Delta B_{\parallel}$ is inferred to originate primarily from the horizontal electric currents in the ionosphere that are closely connected with the Region 1 and 2 field-aligned currents. The magnitude of $\Delta B_{\parallel}$ shows a clear seasonal dependence; it is approximately twice in the sunlit southern hemisphere than that in the northern dark hemisphere in November 1979.

Fig. 4 shows an example of the latitudinal profile of horizontal geomagnetic perturbation vectors observed with MAGSAT in the northern hemisphere during 1722-1744 UT on November 7, 1979.

4-3. Dawn-dusk asymmetry of daily geomagnetic variations at the MAGSAT level and on the ground

H. Maeda, T. Kamei and T. Iyemori compared the dawn-dusk asymmetry of the observed geomagnetic variations at the MAGSAT level and at 16 stations on the ground, which contained the effect from electric currents flowing in the ionosphere and magnetosphere. The dawn-dusk asymmetry of the magnetic field deviations from MGST(6/80) model is shown in Fig. 5 for the ground and MAGSAT data for November 5-6, 1979. On these two days, the effect of Sq current seems to be stronger in the dusk side than in the dawn side. After a method proposed by Maeda (submitted to J. Geomag. Geoelectr.), the observed ground values are separated into two parts of ionospheric and magnetospheric origins, as shown in Fig. 6. It was concluded that

1) The dawn-dusk asymmetry in H and Z near the equator is mostly due to the ionospheric current with equatorial electrojet.

2) A small positive bulge in D centred near the equator seems to reveal the influence of the magnetospheric field-aligned current flowing from the Sq current vortex center in the winter hemisphere to the summer hemisphere.

Although the above inferences must be checked with more data, the analysis of dawn-dusk asymmetry of the observed geomagnetic field will contribute to the study of three-dimensional current flow in the ionosphere and magnetosphere.

4-4. Electric current across MAGSAT orbit loop

A. Suzuki calculated the total amount of electric current flowing through the plane of MAGSAT orbit loop after integrating the tangential component of the observed magnetic field along a complete satellite orbit loop; this is a direct application of Maxwell's equation. His result shows that the total electric current is 1-5 million Amperes, and the current direction is either sunward or anti-sunward. Although a precise interpretation of this result may

be difficult, the result is still wothwhile noting.

5. Publications

Only oral presentations have been made on the actual MAGSAT data analysis on the occasion of some domestic meetings. Some of the recent results will be presented at the 69th Semi-annual Meeting of the Society of Terrestrial Magnetism and Electricity of Japan in May 1981, and also at the Fourth General Scientific Assembly of the International Association of Geomagnetism and Aeronomy in August 1981 in Edinburgh, Scotland, U.K. (The exact titles and authors of such talks are still unknown to the writer at this stage.)

Conclusions

It is of great benefit to the geophysical community in Japan to receive a set of MAGSAT data from NASA. The work of the individual members of the Japanese MAGSAT Investigation Team has started, and some interesting results are coming out. We hope to be able to report a series of important conclusions in the coming trennial reports, although only some preliminary results are written this time in the second report.

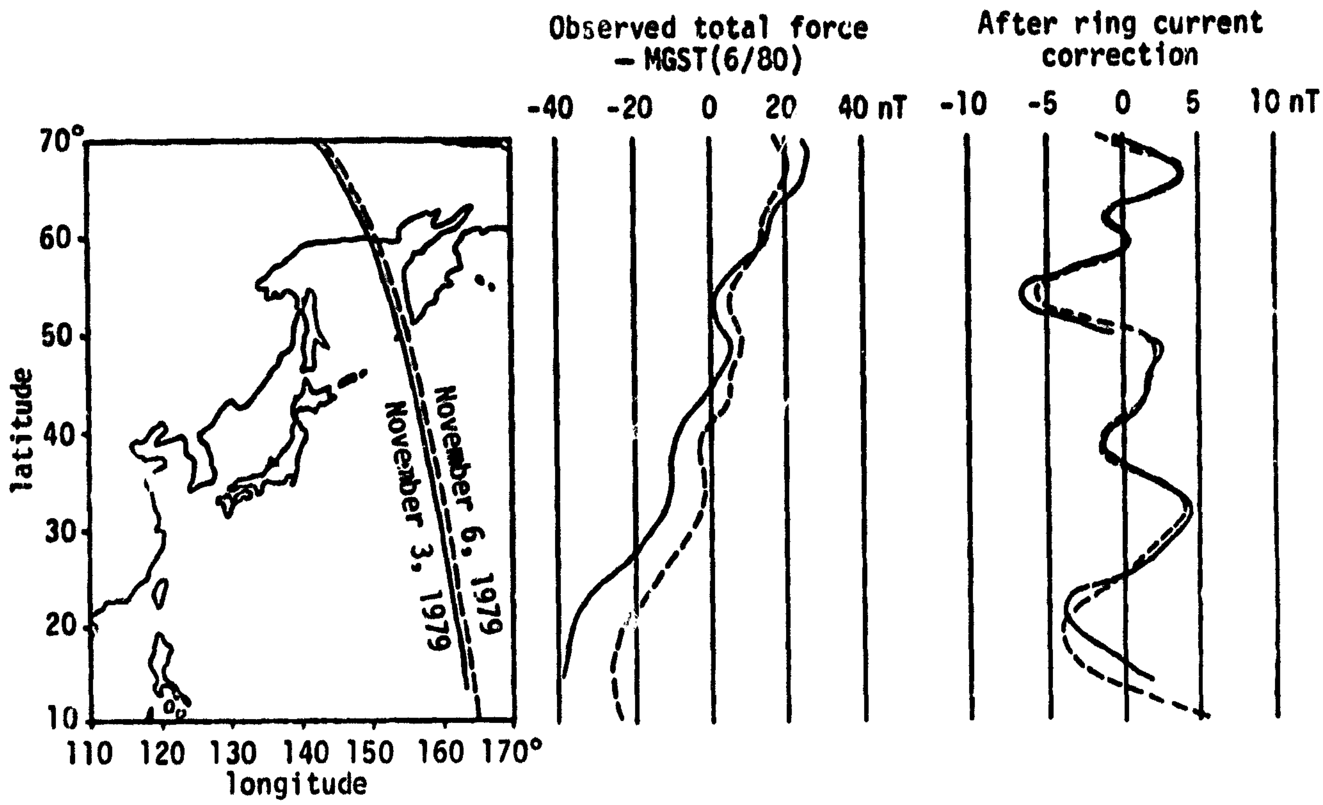

Fig. 1. Two examples of MAGSAT paths, difference of the observed total force from the model field intensity of MGST(6/80), and the anomaly after correcting ring current effect. Solid lines show the data on November 3, 1979, and dashed lines November 6, 1979.

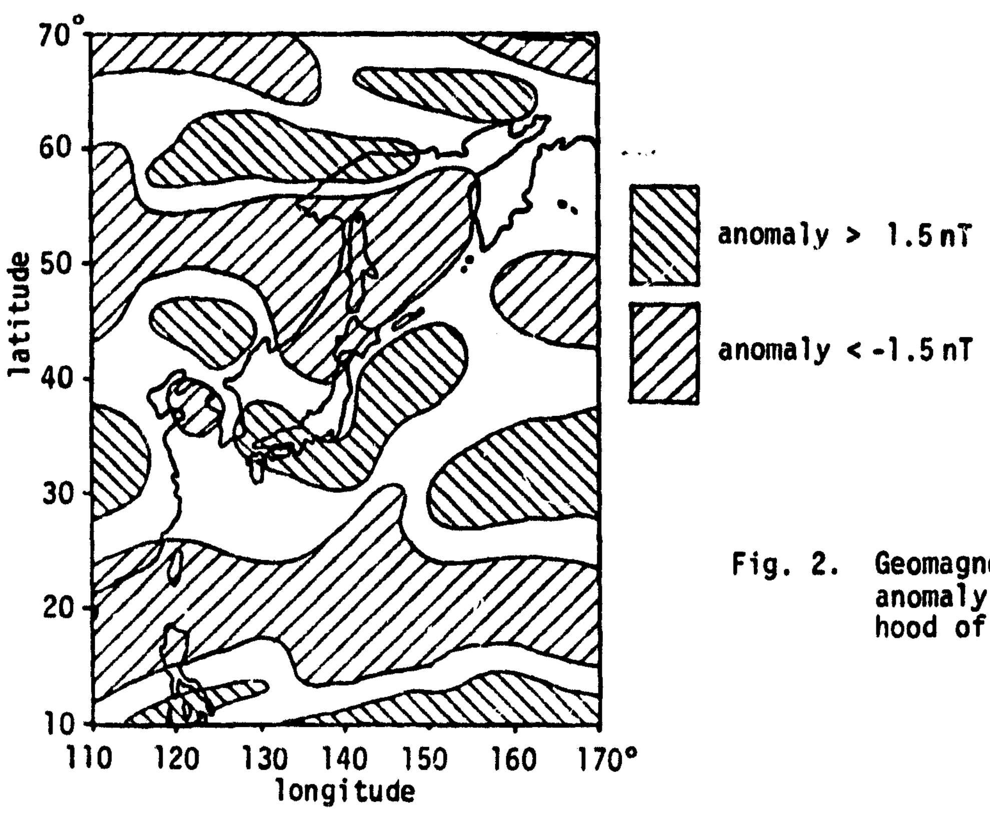

Fig. 2. Geomagnetic total force anomaly in the neighborhood of Japan.

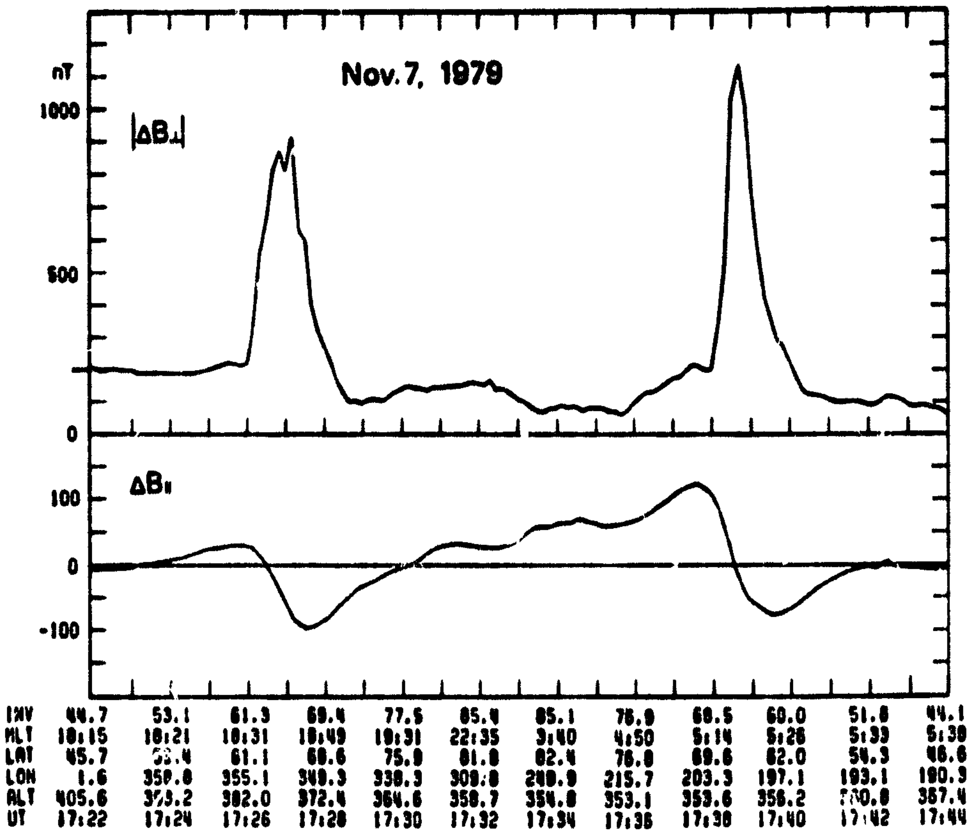

Fig. 3. Geomagnetic vector residuals observed by MAGSAT in northern high latitudes decomposed into $|\Delta B_\perp|$ (transverse to the main geomagnetic field) and $\Delta B_\parallel$ (parallel to the main field) during 1722-1744 UT, November 7, 1979, associated with substorm.

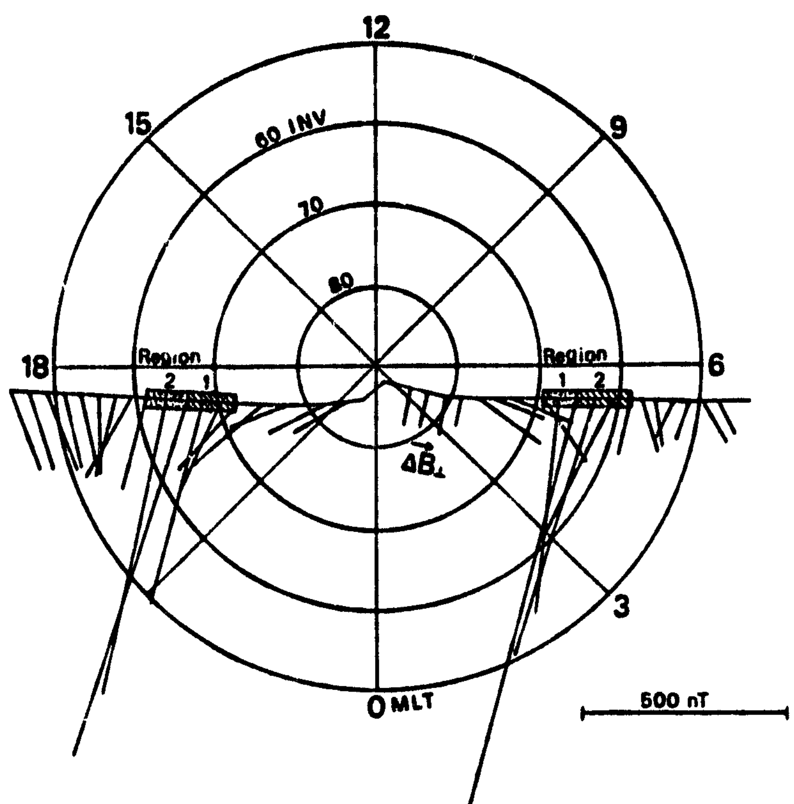

Fig. 4. Transverse perturbation vector $\Delta\vec{B}_\perp$ plotted in the MLT-INV plane for 1722-1743 UT, November 7, 1979. The dotted and hatched areas indicate the field-aligned currents flowing into and away from the ionosphere, conforming to the Region 1 and 2 currents.

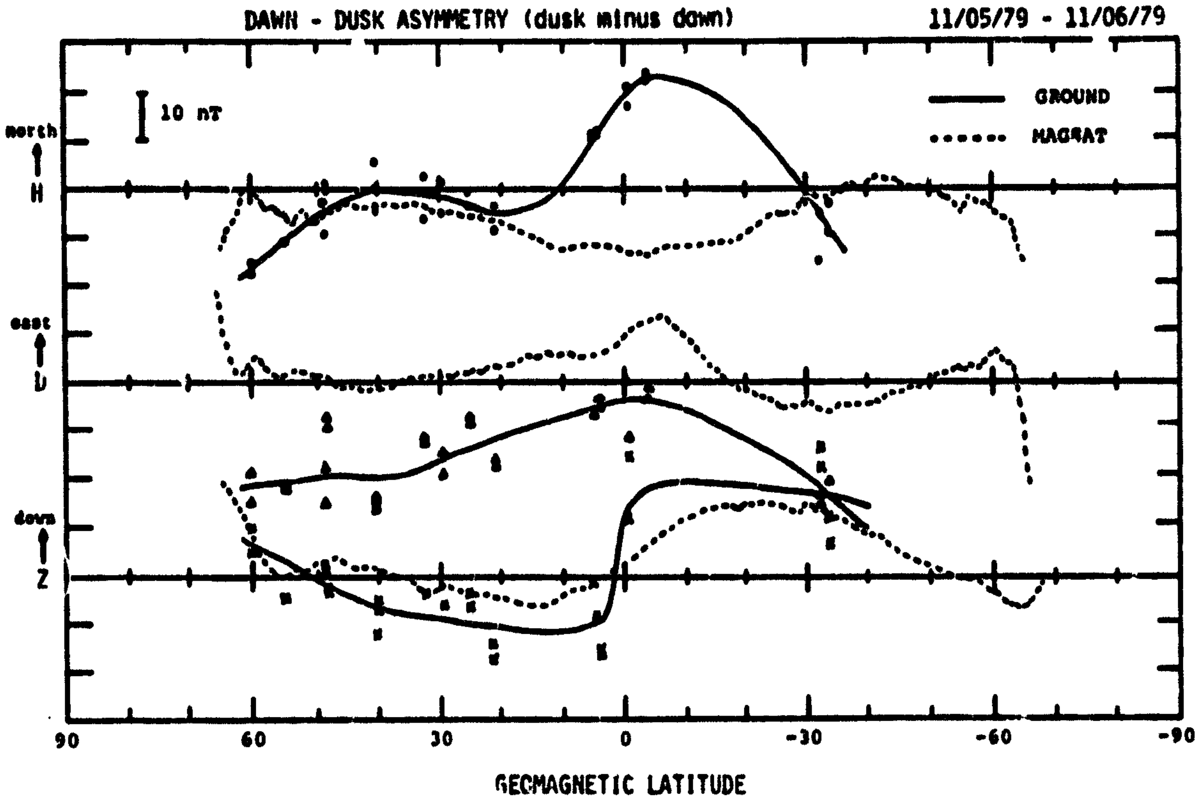

Fig. 5. Dawn-dusk asymmetry of the magnetic field deviations from MGST(6/80) model at the ground and MAGSAT level on November 5-6, 1979.

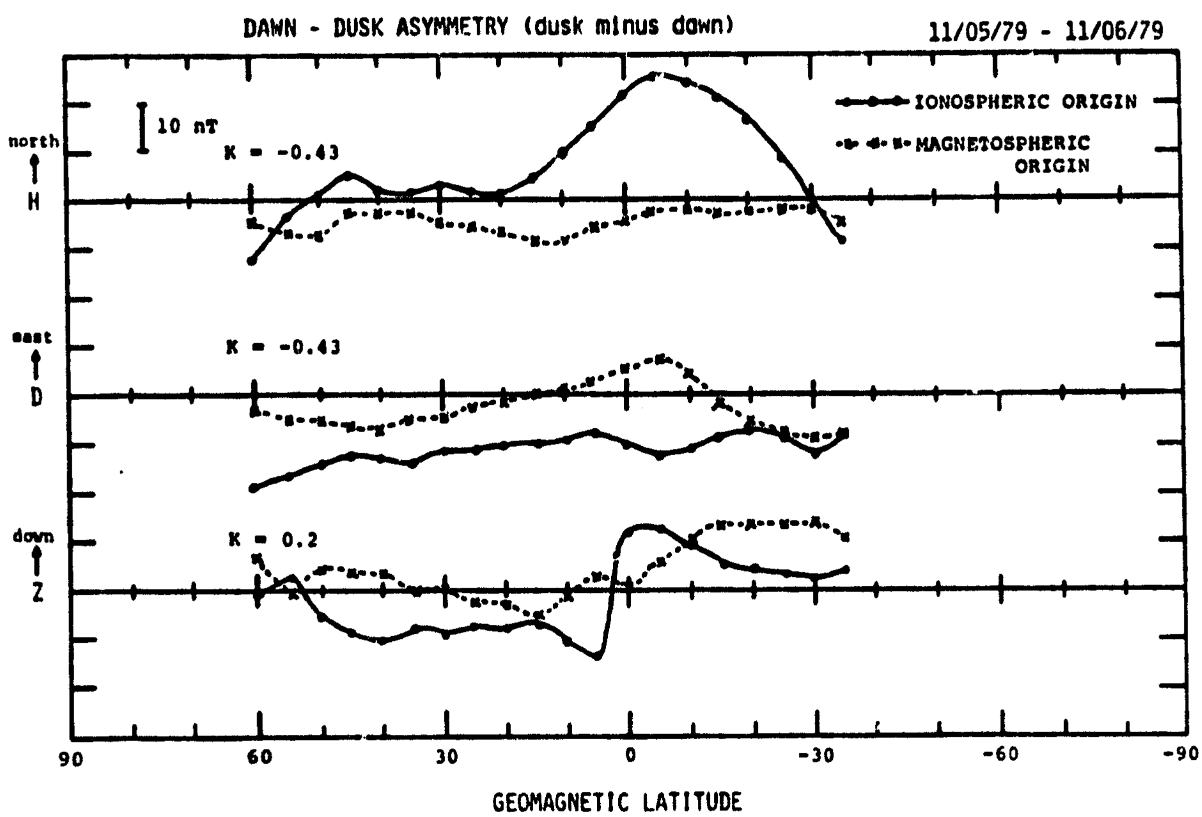

Fig. 6. Separation of the dawn-dusk asymmetry of the ground magnetic data of Fig. 5 into two parts of ionospheric and magnetospheric origins.